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Application of the Cohen, March and Olsen "Garbage Can" decision process theory to the operational Battle Group Commander

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

APPLICATION OF THE COHEN, MARCH AND OLSEN
"GARBAGE CAN" DECISION PROCESS THEORY TO THE
OPERATIONAL BATTLE GROUP COMMANDER

by

William A. Lillard

and

David M. Birdwell

March 1984

Thesis Advisor: R. Weissinger-Baylon

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a review of the topical area in study, and specifically addresses a methodology of data collection in an actual battle group situation for subsequent program implementation and validation. Included in this study is a brief statistical analysis of the program results. The main source of information for the thesis was interviews of senior U.S. Navy officers knowledgeable in the CWC concept and/or Command, Control, and Communications, and an exhaustive literature search of pertinent articles. The main source of program implementation data was the SEACON 84-1 wargaming exercise, conducted November 12-18, 1983 at the Naval War College, Newport, Rhode Island.

Application of the Cohen, March and Olsen "Garbage Can" Decision Process Theory to the Operational Battle Group Commander

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To evaluate the usefulness of a decision support system utilizing the Cohen, March and Olsen "Garbage Can" decision theory in support of Battle Group Command operations. This thesis broadens the knowledge of decision support system application in an operational flag staff organization, with specific emphasis given to the usefulness of the Cohen, March and Olsen garbage can decision model in such an environment. It contains background history on the Composite Warfare Concept (CWC) and interfacing problems, a review of the topical area in study, and specifically addresses a methodology of data collection in an actual battle group situation for subsequent program implementation and validation. Included in this study is a brief statistical analysis of the program results. The main source of information for the thesis was interviews of senior U.S. Navy officers knowledgeable in the CWC concept and/or Command, Control, and Communications, and an exhaustive literature search of pertinent articles. The main source of program implementation data was the SEACON 84-1 wargaming exercise, conducted November 12-18, 1983 at the Naval War College, Newport, Rhode Island.

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I. INTRODUCTION

The operational Flag Commander in command of a multi-faceted Battlegroup has a multitude of "tools" to facilitate the decision process necessary to direct his forces in peace or in war. The number of sensors that provide timely and accurate information about enemy forces is increasing as is the sophistication of the enemy itself. These improved electronic systems coupled with the ever increasing sophistication of the naval forces throughout the world has increased the information available to the flag commander "ten-fold" over his WWII counterpart. This tremendous influx of information available to the commander and staff in the operational decision process can adversely effect the same process through an "information overload". In a normal fleet exercise, as many as 2000 electronically processed messages [Ref.1: p. 16], numerous voice communications and continuous electronic tactical information will be directed to the flag staff in a single 24 hour period. This places a tremendous burden on the command and control structure which is intended to support the decision process.

The command and control structure is a collection of equipment, personnel and procedures designed to assist the decision maker gather, process, and effect composite decisions. Automation within the command and control

organization is no longer an option. Many automated aids have been developed to assist the operational commander such as the Naval Tactical Data Systems (NTDS), Task Force Command and Control Modules (TFCC) and the Outlaw Shark Program. Measuring the success or failure of these systems is not the purpose of this thesis. Rather, the process of decision making within the flag organization, utilizing all available information processing systems is the arena that we wish to examine.

The most popular approach to the examination of the military decision process in the past has been to use the rational model of decision formulation. Although the rational model has been used with some success in the corporate world, it does not satisfy those decision requirements in the military that are outside the realm of simplicity, stability and certainty [Ref 2: p. 2]. In 1972, Cohen, March, and Olsen proposed "The Garbage Can Model of Organizational Choice", which addressed those organizational decision situations which are uncertain and ambiguous in nature [Ref. 3: p. 1]. They imply that the organization, under this model, will have unclear goals, undeveloped decision processes and decision makers who cannot, or will not, devote consistent attention to the organizational problems confronting them [Ref 4: p. 23]. It is within this organizational environment that we will describe the decision process at the flag level.

The central objective in the following chapters is the development of a structured approach to the factors influencing the flag decision process. Specifically, the categories of decisions confronting the flag commander, based on the information available and how that same information moves through the flag staff will be examined. After the "mechanics" of the decision process have been proposed, we will integrate this process with specific areas of applicability using the Garbage Can model of decision making.

The results of our flag interviews compare favorably to flag interviews conducted by Harry E. Allen and David A. Rannells in June 1982 in support of their thesis in a similar area [Ref. 5]. This decision-related information formed the basis for much of the factual information concerning the flag organizational information flow and decision processes. The integration of the Garbage Can theory with the flag decision process is presented not as an exercise in support of the theory but as an insight to the applicability of extensions of the theory to the military decision process. These extensions include deadlines, priorities, decision development triggering and the influence of timing on the process.

Previously, no real military data had been collected and run using the mathematical model developed by Cohen, March and Olsen. Although observations of at-sea fleet exercises

were cancelled due to unit operational commitments, the SEACON 84-1 war game was observed to collect data for input to the model. The program originally written by Cohen, March and Olsen was restructured by Dr. Daniel Guinier, of the Naval Postgraduate School, in support of the decision support research sponsored by NAVELEXSYSCOM. The results of this endeavor are promising. No previous work has provided empirical support for the decision processes and outcomes predicted by the Garbage Can model.

II. THE MODEL AND THE MILITARY DECISION PROCESS

A. OVERVIEW

Military decision makers, although concerned with decisions of both large and small consequences, are no less fallible in the use of logic and influence than are professionals in areas of general management. However, military decision-makers, knowing the consequences of poor, rushed decisions and influenced by events beyond their control, must make decisions under considerable stress whose outcomes can dictate a nation's survival [Ref. 6: p. 16]. The military commander does not operate in a vacuum. At his disposal are numerous sources of information which he may use to formulate and execute his decisions. This information is in the form of electronic message traffic, tactical display systems and intelligence data.

Until recently, the theories concerning organizational decision making as supported by the concept of rationality have dictated a structured choice process. Within this assumption, a decision maker, acting under a set or group of consistent goals and preferences, identifies as many courses of action as possible, weighs the alternatives and selects the optimizing alternative [Ref. 2: p. 1].

The rational model approach assumes that a decision maker will make a choice based on predetermined preferences

and alternatives utilizing known techniques for relating these preferences and alternatives [Ref. 2: p. 2]. In other words, the decision maker knows what he wants, how to get it and has the means and power to attain his goals based on information he assumes to be correct. This model finds little acceptance in the military decision process except for routine administrative occurrences. The very nature of the operational decision process faced by the battle group commander precludes the assumptions stated in the rational model. The commander is faced with operational decisions with uncertain goals and choices, and must work with an organizational structure which does not support the optimizing approach of the rational decision process. As Jay R. Galbraith has said concerning the planning process:

> "...the greater the task uncertainty the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance. The basic effect of uncertainty is to limit the ability of the organization to pre-plan or to make decisions about activities in advance of their execution." [Ref. 7: p. 28]

Many alternative approaches to organizational decision making have been presented in lieu of the rational model. Herbert Simon (1958), James March (1967), Richard Cybert (1967), and Graham Allison (1969), have provided examinations of the limitations of the rational model and proposed alternative approaches to the decision process [Ref. 2: p. 2]. These various approaches have been described in detail in two recent theses at the Naval

Postgraduate School. (These are noted as References 5 and 8.) This research endeavor will consider only the approach presented by Cohen, March and Olsen in Ambiguity and Choice in Organizations. The authors present a model or process which attempts to explain behaviors within an organization which were previously unexplained or ambiguous.

The military commander (specifically the battle group commander) faces uncertainty or ambiguity in most decisions within a tactical or strategic environment. There is a level of risk to be realized within this environment regardless of the information he has on which to base his decisions. Ambiguity must be contrasted with levels of risk and ignorance. As stated by Yates and Zukowski:

> "A decision situation is said to be risky if the decision maker does not know for certain what the ultimate outcomes of his choices will be; yet he holds very orderly opinions about the relative chances of the outcomes actually occurring." [Ref. 9: p. 19]

If the decision maker has no basis whatsoever on which to judge the relative likelihood of the potential outcomes of his decision options, ambiguous decision situations will exist between the extremes of risk and ignorance [Ref. 9: p. 19]. Hopefully, a military commander will tend toward a decision based on risk and not that of the hasty decision based on ignorance. The Garbage Can model, as discussed here, is that process within a military organization which will tend toward a decision based on actions bounded by the information (electronic, intelligence, tactical, etc.)

available under outcomes which are, in a tactical sense, ambiguous.

Before discussing the correlation between the model and the decision process within a battle group or flag staff, an overview of the garbage can process is required to provide a foundation for a more specific discussion of Garbage Can mechanics.

B. THE GARBAGE CAN MODEL

Within the framework of the Garbage Can model, the organizational process can be viewed as several relatively independent streams or variables within an organization which come together within a "garbage can" or "arena". These variables are: Problems, Solutions, Participants and Choice Opportunities [Ref. 4: p. 26]. Problems are recognized as concerns inside and outside the organization. They arise within the arenas in which an organization exists at the time they are identified. They are different from choices and may or may not be resolved when choices are made. Solutions are the product of someone's, or some group's, intelligence. Many times they are considered answers actively looking for a question or problem to solve. March and Olsen suggest that within the context of organizational problem solving, the question cannot be determined without first observing the solution. This denotes the ambiguity of the situation. Participants will

enter and leave the "decision arena" due to their own preference or because other problems have placed demands on them. In this this way we can witness decision makers moving between problems and choice situations freely, as the environment may dictate. Choice opportunities exist when the organization is expected to exhibit behavior that can be determined to be a decision or a course of action. Because these choice opportunities may be of different or finite duration, they may overlap, thus producing several streams or garbage cans active at one time [Ref. 4: p. 26, Ref. 10: pp. 1-3].

Cohen, March and Olsen present an overview of the decision structure as a mapping of individuals on choice opportunities or, as explained by Dr Lawson, "the rights of the streams to participate in a choice opportunity" [Ref. 10: p. 1]. The authors describe this environment as an array where N potential participants and M classes of choices are represented by a decision structure in the form of an N-by-M array. This array shows for every possible participant the choice in which he has a right or claim to participate. In the simplest case it is assumed that the individual either has such a right or does not. This example does not attempt to display the infinite possibilities of all influences on the structure of an actual decision process. It does, however, give insight into

the three major modes or organizing participation rights [Ref. 4: pp.28-31, Ref. 10: p. 5]:

1. <u>Unsegmented Participation</u>

In this structure any decision maker can participate in any active choice opportunity or garbage can. This structure is represented by the following matrix:

$$D0 = \begin{matrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{matrix}$$

Here dij = 1 if the i th decision maker (vertical column) can have access to the j th choice opportunity (across the top). This is denoted by the number "1" at the intersection of any row and column.

2. <u>Hierarchical Participation</u>

This structure places (both) decision makers and choice opportunities in a hierarchy where the order of importance is the key to participation. Here, important decisions are made by important persons and the important decision makers can participate in all choices. As the decision flow proceeds downward to the less important decision maker, decisions can be made only in choice opportunities consummate with the person's status or rank. This structure is represented by the following matrix:

$$D1 = \begin{matrix} 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{matrix}$$

3. Specialized Participation

This structure places each decision maker with a single choice and each choice with a single decision maker. The decision makers specialize in the choices to which they will participate, but Dr Lawson has modified the structure of the array to show that in a military environment (or large organization), the "boss" may participate in any or all choices if he so desires [Ref. 2: pp. 28-31]. This structure is represented by the following matrix:

$$D2 = \begin{matrix} 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix}$$

Observations showing the access structure can be defined in the same manner in which participation access was developed above. The matrices may again be unsegmented, hierarchical or specialized.

These cases (participation and access) represent clear, well-defined occurrences of organizational decision structure. In most real organizations, a mix of participation and access rules will exist. Decision makers will allocate energy and time to choices and problems. In many cases, the energy available to devote to a problem is not consistent with the time given for a problem to be solved. A decision maker must distribute his available time and energy to choices and problems based on preference, priority, or organizational goals and objectives.

Three conditions will prevail when an organization is operating within the garbage can modeling arena. First, organizational goals are unclear or ambiguous. The relative importance of goals or objectives will vary with time or circumstances. Secondly, the technology is not clear. The decision maker does not have the means of accomplishing goals which are not clear or understood. Finally, decision maker attention, or participation, is fluid. He may enter and leave garbage cans independent of any agenda. The decision maker is recognized as having limited time to devote to specific problems, causing "breaks" or inconsistencies in the natural flow of the process itself [Ref. 10: p. 7].

Within a garbage can, decisions may be made in three different ways; flight, oversight and resolution. In a flight situation, a choice may be associated with a problem for a period of time until a more attractive choice to the problem arrives in the decision arena. The problem will leave the original choice and "transfer" to the new one. The original decision will be made, but in the authors' words, "it does not solve anything". An oversight situation exists if a choice becomes activated by the arrival of a new problem. When existing problems are resident in other garbage cans (assuming energy is available to make the decision), the choice decision will be made quickly without considering existing problems, and with minimum time and

effort expended. Finally, decisions can be made by resolution, that is, choices will resolve problems after working on them for a period of time. This is the familiar context of a normal decision process [Ref. 10: p. 7].

The decision style of the organization, (i.e., performance), can be described within the above context as problem activity, problem latency, decision maker activity and decision difficulty [Ref 4: pp. 33-34]. Problem activity is the measure of the activity of problems within an organization. This will be a measure of the degree of problem energy within the organization. Problem latency is the measure of time a problem is active but not attached to a choice, or as Dr J. S. Lawson puts it, "nobody's working on it (the problem)" [Ref 10: p. 9]. Decision maker activity is noted by the number of times a decision maker moves from one choice situation to another. Finally, decision difficulty characterizes the ease with which an organization makes decisions. This is not a measure of problem activity but one of summing the total period of time in which a choice is active in a system.

Cohen and March developed a simulation model, in order to test the general assumptions of the model and subsequent decision performance. They issued their basic findings as eight summary statistics which are reviewed by Dr Lawson in [Ref. 10: p. 9].

1. Resolution is not the most common style for making decisions, except under light load or when flight is severely restricted. Flight and oversight seem to be more prevalent.

2. The process is thoroughly sensitive to load. High loading leads to lots of decision maker activity, but few resolutions, and choices take longer to make.

3. DM's and problems seem to track each other through choices. They tend to move together from choice to choice. One result is that the DM's may feel that they are always working on the same problem no matter where they go.

4. Presumably an efficient organization tries to keep both problem activity and problem latency low through rapid resolution of problems. This was never observed in this model.

5. Many of the outcomes are distinct consequences of the particular time phasing of choices (solutions?), problems, and participant availability.

6. Important choices are much less likely to be made than unimportant ones. Early arriving problems are more apt to be solved than those that arrive later.

7. Important choices are much less likely to resolve problems than are unimportant choices (meaning of "choice unclear"). Important choices are made by flight and oversight. The unimportant ones are made by resolution.

8. Although most of the choices (decisions?) do get made, the choice failures that do occur are concentrated amongst the most and least important. The important ones which arrive late do not find enough energy available to get solved and the unimportant ones are defeated by the queue length. Intermediate choices are nearly always made [Ref. 10: p. 9].

The Garbage Can model and its preconditions do have an intuitive correlation to many decision processes within the military organization, specifically within the decision process exhibited by the battle group commander and his staff. In the next section the Garbage Can model will be applied to the military process as well as some extensions of the model required to describe the aspects of decision making within the tactical military organization.

C. THE MILITARY DECISION MAKER AND THE MODEL

The correlation between the decision modeling characteristics as described by the Garbage Can model and the decision process of the battle group commander is significant in many aspects. The framework of the Garbage Can model where streams or variables come together within a Garbage Can, or "arena", can functionally correlate with the battle group or staff process. Problems are recognized within the staff as either Tactical, Strategic or Administrative in nature. Participants include the battle

group commander, staff, and senior and subordinate commands (advisory and supportive). Solutions are the product of someone's intelligence. Here, it is the product of the group commanders' efforts through his supporting staff, many times paralleled by subordinate commanders' efforts in their assigned areas of responsibility. Regardless of support responsibilities, it must be understood that no matter how much staff deliberation occurs in a choice opportunity, the decision is still that of the battle group commander and not the responsibility of the battle group organization.

Contrary to the world of management, many decisions are considered those of the organization and not of the top official or CEO. Solutions in the military, as in the business community, often enter the decision arena looking for a problem with which to attach themselves. Within a battle group staff, members will transfer unique abilities, experience or education to choice opportunities where problems may or may not reside. If problems do reside within a choice opportunity, the solution can attach itself and the decision maker's energy can then be applied to other problem situations. However, many times these solutions looking for problems can create problems that only the decision maker, or his staff, recognizes as such. If this is the case, excess energy will be spent at the expense of other, possibly more important problems in the justification and "selling process" necessary to support the problem.

Additionally, as March and Olsen have stated, it might be that the question cannot be determined until we first observe the solution. In the military context, this ambiguity in choice is seen at many levels. Specifically in the tactical arena, a commander will not be able to determine which tangents are within an acceptable risk boundary until he has decided the mix of weapons and aircraft or ships he has at his command. Participants within this ambiguous decision arena will move between problems and choice arenas as the situations dictate or as energy is available. Staff members will very rarely work on only one problem in any given time. All will be assigned areas of responsibility to which their energy is expected to be directed. However, this channelled energy will be directed to global problems, whereas staff members are in a staff watch status or else their specific areas of responsibility and problem/decision interaction are a part of a larger decision arena which requires their combined energies to manipulate a decision process.

The mapping of individuals to choice opportunities, as described in the matrix organization presented by March and Olsen [Refs. 2 and 10], is very useful when describing the military commander and staff relationships in both specific and global decision environments. Participation rights will again be pointed out, but as in the initial explanation,

these rights apply to access rights as well [Ref. 10: pp. 5-6].

1. In the unsegmented participation matrix, any decision maker or staff member can participate in any active choice opportunity or garbage can. This situation would prevail in a staff meeting environment where problems and solutions are discussed and solutions developed. Any decision maker, regardless of station, can approach a problem or choice opportunity as his desires or available energies dictate.

2. The hierarchical participation matrix places both decision makers and choice opportunities such that the order of importance is the key to participation. The more important the decision required or choice opportunity available, the higher up the chain of command the decision maker will be located. This organization is probably the most prevalent in the battle group organization. Again, it must be kept in mind that those choices dealing with tactical or strategic opportunities will usually be represented by participation of the battle group commander, but various choice opportunities will be developed by lower level subordinates or subordinate commands before being processed into one major choice opportunity to be acted upon by the commander.

3. The specialized participation structure places each decision maker with a single choice and each choice with a single decision maker. Although the decision makers will

specialize in the choices to which they will participate, in the military environment, the senior person can participate, or have access to, any and all choices. This is the case where the staff officers work within their specialties supporting the larger, more complex choice opportunities at higher levels. Here, the battle group commander will accept inputs from all functional areas (i.e., Operations, AAW, ASW, ASU, Weapons, and Engineering) and formulate an overall decision with regard to a problem within a choice opportunity in which he must participate in order to develop an acceptable solution.

As noted in section two of this chapter, these cases represent clear extreme occurrences of the organizational decision structure. The battle group commander's organization, as any other organization, will be seen as a mix of all of these structures, interdependent and overlapping in almost every situation. The military staff member, as well as the commander himself, will allocate his time and energy to choice situations based on priority, preference, time goals and objectives.

The preconditions assumed for organizations operating within the Garbage Can arena are closely met by the battle group commander's organization. Briefly paralleling these conditions, it can be seen that the goals and objectives of the battle group will vary with time or circumstance as the tactical organization transits from one readiness condition

or situation to another. As specific environments are encountered, the battle group staff will find that stated organizational goals or procedures are not germane to the existing situation. Secondly, the means of accomplishing the goals will not be fully understood or envisioned for these ambiguous occurrences. Finally, the more ambiguous the goals or choice opportunities appear to be, the less time staff decision makers will have to devote to specific problems. As the information available to the decision makers increases, they must limit the total amount of time spent on any one problem, and in many cases, must devote excess energy to top priority problems, causing further breaks in the flow of the overall decision process.

If we keep the three preconditions given above in perspective, the manner in which decisions are made (flight, oversight, resolution) seems realistic within the battle group environment. Decisions made by flight are characterized by the decision maker working with one choice situation until a problem of a higher priority or more pressing time limit is realized. The energies devoted to the original problem will be transferred to the more pressing situation, with the original problem "kicked downstairs" to subordinates for resolution, or perhaps considered solved because it was overcome by events.

Problems solved by oversight in a battle group situation are best characterized by those occurrences which must be

dealt with quickly in a high tempo environment such as a hot-war or battle situation. Minimum time and energy will be expended by the commander and staff because of the time constraint dictated by the situation. Although consideration of other existing problems is not relevant to the problem being acted upon, the decision will not be made with "tunnel vision". The overall tactical picture is current in the mind of the commander and his subordinates and will influence any decisions made.

Finally, decisions developed by resolution can be characterized as those problems which are considered extremely important to the survival of the battle group or those problems which are possibly less important and can be fully staffed at lower levels of the command before being issued as a directive by the commander. Both of these situations will usually be developed utilizing guidelines previously established through Orders of Battle, Operating Plans or Standard Operating Procedures. Resolution of important problems is however, based on the assumption that sufficient time and energy are available to plan and execute the decided actions. Otherwise, these same problems will be decided by flight or oversight. Decision maker attention to decisions will be dictated by what is commonly referred to as attention mechanisms. These "extensions" or environmental changes that evoke decision situations are evident in most, if not all, choice situations facing a

battle group or military commander. Included in this category of environmental stimuli are Triggering, Deadlines, Secret Deadlines, and Timing.

1. Triggers

Chester I. Barnard states that occasions for decisions originate from three sources: superiors, subordinates and initiative of the individual decision maker [Ref. 11]. Here, a direct parallel must be considered between business and the military commander. Triggers can be identified in all areas of the military decision process. Direct orders from superiors, inquiries or responses from subordinates, initiating action derived from the internal staff organization, as well as enemy actions or responses are but a few of the triggers that a commander may implicitly or explicitly originate or perceive. Triggers in the military environment can effect the decision process in varying degrees. If originated by an individual, other higher priority problem areas or choice situations will invariably be put aside so as to investigate the event that has been triggered. If this is done in a self-serving manner by a superior, tactical (realtime) decision situations will suffer. Accordingly, triggers which continuously occur external to the organization, will tend to have the same effect on on-going tactical situations but are much easier to filter or control through proper staff organization. Filtering and control of triggers is important, but in a

military environment, all triggering events must be considered, due to the possible influence they may exert on the operational aspects of the battle forces.

2. <u>Deadlines</u>

Deadlines may be set (or defined) by individuals or circumstances (within and outside the organization). Deadlines serve to cue or direct attention to those choices and problems subject to deadlines and divert attention away from choices and problem situations not affected by deadlines. Deadlines within the decision process can provide a measure of which choice opportunities or problems must be acted upon immediately, and which are of a secondary importance (or lesser deadline) [Ref. 4: p. 226]. Deadlines under ambiguous conditions are explained by March and Olsen [Ref. 4: p. 226] as existing for two reasons:

a. Deadlines may be ambiguous with regard to the problems that must be considered with a given choice.

b. Deadlines may be ambiguous with regard to the date of a deadline. The effectiveness of the deadline many diminish if there is uncertainty associated with the deadline date.

If deadlines are to be effective they must be enforceable and certain. The military commander is faced with deadlines in every aspect of his decision process. They are imposed by seniors and the military environment in which he operates. As with the triggering phenomenon,

deadlines can effect decision maker participation in choice situations. As a firm deadline is approached, attention is diverted from other problems or choice situations to the event which has increased in priority due to the attached deadline. An example of this within the battle group decision process would be plans to monitor ship movements and locations being set aside in order to recover aircraft. Here, we have an established deadline based on aircraft available fuel or weather conditions. Participant energy and attention would be diverted from the initial situation until the aircraft were recovered. But what if the course to recover aircraft took the ship out of range in which to monitor the ship movements, as proposed in the earlier plan? Problems could arise causing severe tactical or strategic consequences. As can be imagined, deadlines must be managed carefully. The battle group commander, as well as his staff, must constantly maneuver within the tactical environment through the manipulation of events or occurrences and their own attached deadlines. Deadlines require and receive more time and energy than would be available or necessary if faced with a normal decision situation. If a deadline were perceived as a "soft deadline" by the decision maker (or staff) when it was in fact "hard", an anomaly known as a "secret deadline" occurs. In a tactical sense once this secret deadline is realized,

reaction by the staff must be immediate with enormous amounts of energy made available to act upon the decision.

The military decision environment was described at length in this chapter to demonstrate that the Garbage Can model provides a framework for understanding decision processes at the battle group commander level. The following chapters provide simulation trials, based on field observations, to give further support to this hypothesis.

III. DECISION ENVIRONMENT

In this chapter, we will briefly describe the flag staff organization, identify specific categories of flag decisions, describe the sources of information available to the flag staff, and pattern the flow of information in a modern battle group. The emergence of the Composite Warfare Commander (CWC) concept as an organizational standard has provided fleet commanders with a tool to accomplish the decentralization of responsibility and authority within a battle group. It is this structured organization which identifies specific responsibilities to certain decision makers and thus, makes numerical evaluation of the process possible in a garbage can arena. A brief description of the CWC organization will serve to identify the players and their roles.

In the CWC organization, command and control is distributed functionally, and may be distributed physically as well. Various responsibilities for different aspects of a battle group's operations are allocated to specific element coordinators and commanders in a well defined manner. As a result of pre-planning, or more often because of a specific decision during hostilities, the degree of decentralization and delegation of authority can vary from time to time in response to the situation. Examples include

a change in the rules of engagement, the nature of the threat, the degree of electromagnetic radiation emission control, and so on. The general trend is a move away from centralized control by the battle group commander in quiescent periods to delegated control, consistent with plans for action and tactics developed and rehearsed in advance, to specific warfare element commanders. Indeed, as communications integrity deteriorates in a given conflict, prior assignment of specific warfare responsibilities becomes mandatory [Ref. 1: p. 4].

Each area warfare commander must be provided with information if he is to carry out his duties. Each commander requires a somewhat different subset of all the information available, but it is not true that each requires only the information directly relevant to his own arena of operations. Effective command and control of the battle group requires that each warfare area commander must know what other warfare area commanders are doing relevant to his decisions. It is this aspect of responsible decision making that has complicated the design and development of decision support systems for military operations in a given operational environment. Our current sensor systems have evolved to very near real-time data input devices and the resultant need for evaluated and correlated data is real. This has become the driving force behind the development of

an automated decision support system for operational control.

A. CHARACTERISTICS OF FLAG DECISIONS

Flag level decisions can be grouped into three general categories of decision types; i.e., planning, execution, and evaluation [Ref. 5: p. 18]. These three categories transcend different decision environments and mirror battle group operations.

Planning decisions are those usually relevant to the construction of a flag officer's operation order and are made within the time frame of a few days to several months, with large amounts of very good information which typically cover a large number of contingencies.

Execution decisions begin as soon as ships leave port. Critical here, as related by almost every flag officer interviewed is that the major emphasis of the flag officer shifts from operational planning to ensuring that the operation proceeds as planned. The process of how decisions are reached for problem situations not covered in the contingency section of the operation order are of specific interest to us. Time will be an important factor here as delays in the decision process may cause important losses. The decisions may contain a degree of uncertainty and risk as they are dependent upon, among other factors, the

timeliness and accuracy of the supporting information [Ref. 2: p. 38].

Evaluation decisions include those made immediately following the first engagement and pertain to the assessment of losses for the battle group and the extent of damage inflicted on the enemy. From these decisions, planning for the follow-on attack and formation of new operations or strikes may begin. Solutions relative to pertinent problems may assume different weights or levels of acceptability and other options may become unacceptable alternatives. By closely examining the decisions of a battle group commander and reviewing the options available or readily known at the time, decisions fall into four typical categories: routine, priority, strategic and "shoot-don't shoot".

Routine decisions are those largely administrative in nature, concerning general steaming orders, orders to attached forces concerning support services, and so on. They are typified by those decisions made in a near perfect information environment, under little time pressure or constraint, and generally define command attitude or policy.

Priority decisions are those decisions which have an up-front, often pressing time constraint and concern the actions of own forces, without regard to international effects or ramifications. Operation order changes and shifts in current battle group commander attitude typify these decisions.

Strategic decisions concern those pressing operational constraints of an international nature. Typically, these decisions are surrounded by large amounts of information, and impact on several areas of concern, namely long and short range goals.

Shoot-Don't Shoot decisions are those real-time, hot war decisions concerning weapons employment. Characteristically, these decisions initially follow planning documents, operation orders, rules of engagement, and naval tactical memos. But as a given situation in a particular theater deteriorates, guidelines become less definitive as the quality of communications worsens and the reliability of information available to the battle group commander plummets.

The net sum of examining categories and characteristics of a battle group commander's decision process is that individual options can be identified for numerical identification and manipulation. A graphic representation of the overlap of decision characteristics and categories shows the relationship between each:

```
* ROUTINE * PRIORITY * STRATEGIC * SHOOT/ DON'T SHOOT
*         *          *           *
*****************************************************
*         *          *           *
*                         I --- evaluation --- I
*
*             I --------- execution ---------- I
*
*I ----- planning ----- I
```

Figure 1. Decision Characteristics and Categories

The cumulative nature of the process tends to be cyclical in operation; i.e., the evaluation phase ultimately culminates in routine planning changes. But the process under study is the flag decision process and some observations of that process should be made due to their importance in the modeling process.

1. Flag level decisions tend to be non-repetitive. Repetitive decisions are usually delegated to staff members or subordinate commanders.

2. General policy and force attitude are set by the flag commander.

3. Timing of most flag level decisions is important and the consequences of bad timing can be devastating. Guidelines covering as many contingencies as possible serve to reduce decision error in emergency situations and reduce the time necessary to reach a given decision. The next step in the analysis process is to examine the types of information and input available to a battle group commander.

The information flowing to the Command Center must be of high quality and timely in nature. Information flowing to the battle group commander is of two specific types: tactical and strategic. This classification is advantageous because the two types are handled in different manners; tactical information is generally considered to be of a more immediate nature and presents a real-time picture of the current battle situation, whereas strategic information is not often of immediate importance, but should be considered in forward planning [Ref. 5: p. 22]. Many factors including national interests pursuits, global politics, and mission purpose will impact which category is appropriate for a

given bit of information. As weapon systems continue to evolve toward an increased effective range, battle group commanders must become concerned about damage to the battle group at greater distances from the enemy; the effect is a shift toward an increase in tactical information at the expense of strategic information. The net effect of the shift is to increase the number of factors and variables which are to be considered in a tactical, real-time battle group decision.

IV. DATA COLLECTION AND MODELING PROCESS INPUT

The modeling concept as developed in the previous chapters has been further supported and tested by us through "realtime" data collection and the application of a unique modeling concept developed by Dr. Daniel L. Guinier at the Naval Postgraduate School. The purpose of this chapter is to discuss the data source, data collection and model input of the data. Of particular importance in this chapter is the method by which decision makers, problems and choice situations were identified and prepared for input to the model. The actual simulation findings derived from this model will be discussed in the three remaining chapters. The data used for input for this modeling simulation were collected during SEACON 84-1, conducted at the Center for Wargaming, Newport, Rhode Island, from 10-18 November, 1983. This wargame was developed to allow senior DOD officials to participate in a military decision making environment. Participation in the wargame was further supplemented by the Carrier Group One Staff, RADM P.F. McCarthy, commanding. Additional support was provided by experienced officers from all the services who participated in the wargame in those areas where their specific expertise could be capitalized upon.

The game situation was developed as an open ocean fleet engagement between two superpowers which escalated from a "cold war" environment through various stages of hostilities, to a full scale, wartime confrontation. We were placed in a unique position within the game structure to facilitate the data collection and verification process with which to gather data for input into the Garbage Can Process simulation. We were assigned within the command structure of the Blue force staff as officers in charge of the Bravo Whiskey (Anti Air Warfare Commander) and Bravo Sierra (Surface Warfare Commander) command modules. This arrangement allowed us to not only witness the process, but to participate in the decision arena as well. Data were accumulated on a daily basis from the module logs and from our own "realtime" observations of the Blue Force Command decision process. Additionally, the Center for Wargaming (specifically Commander Dick Adams) provided a complete package of data generated from the game in the form of (1) all messages generated by the various command modules (2) a complete track history of all forces and (3) engagement reports generated from the game floor. This extensive data source combined with our observations from a player's viewpoint, provided a perspective of the various decisions at all levels of command as well as the decision processes which supported the commanders' actions throughout the wargame. The complete data package was screened and broken

down into selected data boundaries which could be used as data input for the Garbage Can Modeling simulation. This data was refined under the direction of Dr Guinier and run on a Vax 11/780 at the Naval Postgraduate School. These data boundaries consisted of the following:

10 decision makers
6 choices
20 problems
28 entry times

Ten (10) decision makers, representing ten key decision making positions within the wargaming hierarchy, were identified. Clear choice opportunities (6) as well as their attendant problems (20) were matched with these specific decision makers to exemplify the decision arena that was to be utilized within the representative modeling simulation. The data input required by the methodology, in support of the simulation was segmented every thirty (30) minutes, or twice an hour. These time periods were further represented by the twenty-eight (28) time periods that are used by the simulation to denote problem entry times. The specific data items drawn from the wargame for use in the modeling simulation are presented with summary representations. This is done to provide an insight into the methodology and justification of the process utilized to develop the data input to the model.

A. DECISION MAKER ASSIGNMENT

All decision makers are present throughout the simulation. Although they move from one choice to another, they remain within the decision arena throughout the wargame. They are listed below in ranking of importance to the decision process, which is itself identified by the choice and problem applications explained later in this section.

1. D1 - RADM P.F. McCarthy

RADM McCarthy is presently Commander Carrier Group One (COMCARGRU ONE). During the wargame (SEACON 1-84) he acted as Commander, Task Force 30 in overall command of the two Battle Groups, Task Group 30.1 and Task Group 30.2. Key members of RADM McCarthy's staff are noted as individual decision makers, as they provided key inputs and decision support within the identified choice and problem identification process.

2. D2 - Captain Ward

Capt Ward is presently chief of Staff, COMCARGRU ONE. He acted in the same capacity during the wargame as Chief of Staff, Commander Task Force 30. Capt Ward's extensive experience in submarines and anti-submarine warfare was tantamount to his being identified as a key decision maker within the Task Force organization.

3. D3/D4 - Commander Phillips / Commander Lovett

Cdr Phillips and Cdr Lovett are experienced aviators with air operations and anti-submarine warfare backgrounds. Both are attached to COMCARGRU ONE Staff and acted in a similar capacity during the wargames. The nature of the threat, that is, Red Air and Red Force submarines well justified the choice of these two officers as key decision makers.

4. D5 - Captain Lewis

Captain Lewis is an experienced Surface Warfare Officer with extensive service in both surface ships and Staff positions. He is presently attached to the staff of COMCARGRU ONE. As Commander, Task Group 30.2 for the wargame, he was responsible for the decisions and actions within Task Group 30.2 as defined by existing choices and problem situations.

5. D6 - Lieutenant Commander Buletza

Lcdr Buletza acted as Deputy, Commander Task Group 30.1 (CV Battle Group A) during the wargame. He was the principal advisor to the Battle Group Commander for all matters effecting the ALPHA (A) Battle Group.

6. D7/D8 - Lieutenant Birdwell and Lieutenant Commander Lillard

LT Birdwell / Lcdr Lillard (the authors) acted as surface ship and anti-air warfare commanders for Task Force 30.2. Both have extensive experience aboard Guided Missile

Cruiser and Destroyer type ships which provided credibility to their positions as decision makers in support of overall force defense.

7. D9 - Commander D.A. Clark

Commander Clark is an experienced Surface Warfare Officer currently enroute to assume the duties as commanding officer of a FFG-7 class destroyer. During the wargame he acted as CTF30.1, Anti-Submarine Warfare Commander for the Bravo Battlegroup.

8. D10 - Lieutenant Commander A Gideon USN

Lcdr A. Gideon, is an experienced nuclear submarine officer. He acted as deputy to the Commander Task Group 30.1, Anti-submarine (subsurface) Warfare Commander.

B. CHOICES [6] AND PROBLEMS [20]

The choice situations are listed and utilized within the model in the order in which they occurred. The same choices, if listed in order of importance, would be identified as choice 1, 6, 3, 4, 2 and 5, respectively. Problems that are attached to the choices are numbered in the order in which they occurred. Choice situations and their attendant problems were identified, on an attentive basis throughout the wargame and substantiated through BLUE force intentions meetings, held twice daily by the Commander, Task Force 30 (RADM McCarthy). Upon completion of the wargame, the six choices and attached problems were

chosen from an inclusive list developed over the course of events of the past week. Specifically, the following determinants were used to select the choice situations implemented within the model:

1. Which particular event(s) created the choice situation with the greatest overall threat to the Blue force?

2. Which specific event(s) created the choice situation that would result in the greatest potential loss of life and/or material to the Blue forces?

3. Which specific event(s) created the choice situation that presented the greatest loss of political posture to the Blue forces?

4. Which event(s) created the choice situation that represented the highest potential damage to Blue force intelligence, and subsequently, the greatest loss of Blue force security?

5. Which event(s) created the choice situation that would adversely affect routine Battle Group operations resulting in a reduction in the overall mission effectiveness of Blue forces?

This listing was discussed with the key decision makers and staff of COMCARGRU ONE with the following list developed as those choice situations and problems which played key roles in determining the strategic outcome of the wargame.

1. Choice #1

Should the Task Force go out of EMCON following the overflight by RED force reconnaissance? If the force has been identified, further EMCON procedures could have a negative effect on the task force readiness posture. However, if the force has not been identified, breaking EMCON could indicate the BLUE force location and disposition to the RED forces. Choice #1 was noted as the most important of the six choices. From a strategic standpoint, the overflight by Red aircraft posed a significant threat to the force. As in World War II, the location of friendly forces must remain unknown to the enemy. An allied Commander must be able to strike the enemy on his own terms. Early detection of friendly forces by the enemy would allow for timely targeting procedures by surveillance craft as well as a first strike opportunity against the main body of friendly forces.

Problems 1-4 are attached to choice #1 as follows:

1. Internal pressure is present within the task force to come out of EMCON. (Subordinate Staffs)

2. Internal pressure is present to stay in present EMCON plan. (Subordinate Staffs)

3. There is a perceived need to revise the EMCON status of the BLUE forces. (Subordinate Staffs)

4. There is a perceived need to develop a contingency plan to revise the EMCON status of the BLUE forces. (Subordinate Staffs)

These problems are closely related to the content of the various actions which must be developed to act on the problems and the method in which the problems need to be resolved. The internal pressures present within the staff and subordinate commands with which these problems were associated were noted through the message traffic, voice communications and the daily commanders' briefings. Problem 2 was eventually attached to choice 2 and measures to solve the EMCON dilemma were effected in the context of this problem. Solution of this problem presented by the staff was borne out as correct through the RED force message traffic which was reviewed after the wargame.

2. Choice #2

A strike against the RED force must be considered by the Task Force Commander. The Surface Group Commander and the Anti-air Warfare Commander feel that intelligence is not accumulating quickly enough to allow for a sustained, well developed strike based on intelligence which may become available in the future. This choice situation was noted as the fifth priority item of the six choices presented. The assumptions developed here are not of immediate consequence but are strategically important for the long range survival of the Blue forces. A strike must be planned, but when it will take place is strategically important and cannot be decided too quickly. Intelligence on the overall Red force position and intention was developing too slowly in light of

the recent escalation of hostilities by the Red nations. The Blue force required a strike plan and an opportune time to execute it.

Problems 15-17 are attached to Choice #2 as follows:

15. Unclear and ambiguous information is developed concerning the intentions of the RED forces. (Blue Intelligence)

16. Internal pressure is exerted to strike the RED forces in strength. (Subordinate Staffs)

17. There is a probable high loss of BLUE aircraft with an air strike.

These problems have attached themselves to this choice by virtue of the deteriorating strategic situation and the various force commanders' desire to take action before the enemy strikes. The overall problem is exacerbated through the unclear and ambiguous information that has been received in regard to the RED force disposition. The problem of high loss of aircraft during a strike is a given outcome of any action against the enemy. Whether lost in action against the enemy during a strike or in defense of the force, aircraft will be lost. The problem of the offered air strike plan is accepted and acted upon by the Task Force Commander after review of all associated problems at the Commanders' intentions meeting.

3. Choice #3

Blue Forces must preclude compromise and intelligence data loss following the capture of a BLUE intelligence ship by the RED Battle Group. This choice

situation forced the Task Force Commander to weigh the problems of how to deal with this situation in terms of intelligence compromise weighed against the loss of BLUE force life. This choice situation was first noted in the message traffic from BLUE intelligence reports and substantiated through aircraft voice reports. The choice situation was noted by the combined decision maker hierarchy as being the third in order of importance to the overall wargame strategy on the part of the Blue forces. Although the compromise of Blue intelligence data and possible force position was in jeopardy the situation was somewhat controllable. Continuous voice situation reports were relayed to the Blue Force Commander from a Blue reconnaissance aircraft on station at the scene of the capture. Through constant monitoring of data transmissions from the Red forces in the area, Blue intelligence was able to ascertain any transmission of sensitive data.

Problems 9-11 are attached to choice #3 as follows:

9. The Force Commander must weigh the probabilities of the BLUE loss of life against the compromise of intelligence data.

10. Pressure is exerted within the staff to sink the captured BLUE intelligence ship. (Subordinate Staffs --message and voice transmission)

11. Pressure is exerted by subordinate commanders to rescue the BLUE intelligence ship and crew. (Intelligence Staff and message transmission)

The problems presented to the Task Force Command structure by this choice situation were to become evident

during the Task Group Commander's meetings and through the message traffic to COMBLUE. The problems required diverse actions to accomplish desired ends. Eventually, after weighing all problems presented under this choice situation, the problem of sinking the intelligence ship was considered to be a "least cost" situation to the Commander and Staff. All hands were lost with the sinking of the intelligence ship and its captors. This appeared to be the best choice - problem situation as the RED forces did not know the disposition of the BLUE forces or their intentions until the end of the wargame.

4. Choice #4

A RED force intelligence ship is in a position to collect data on the BLUE Battle Group. This key choice situation, again, describes the importance placed on possible targeting of the BLUE forces. If the position of the Battle Groups were defined, the fate of the BLUE forces would be "sealed". The RED intelligence ship was intercepted by BLUE reconnaissance aircraft and tracked by the "picket" ship radars. This choice situation was defined by the decision makers as number four priority in relation to the six choice situations noted in the wargame. Although this intelligence ship was capable of gathering information as to the position of the Blue Forces and providing targeting data to other Red units, there was no indication that it had the opportunity to do so yet. The Blue force

commander considered this an important event, but one which could be dealt with in a more deliberate manner than choice 1, 6, or 3. This reasoning developed from the assumption that if the Red reconnaissance craft had not gathered any sensitive information, destroying it would bring attention to its location which was within missile range of the Blue Force.

Problems 12-14 are attached to choice #4:

12. Targeting data on BLUE forces may be available to RED Forces from the RED intelligence ship. (Blue Intelligence)

13. Pressure within the BLUE staff and subordinate commands is exerted to sink the RED intelligence ship. (Subordinate Staffs)

14. An Air strike against the intelligence ship could indicate to the RED force the BLUE force location. (Blue Intelligence Staff)

These problems are directed toward the choice situation by the need to keep the position of the BLUE force from RED intelligence gathering units. The various problems were presented to the staff relating to this choice situation through the message traffic from BLUE intelligence and the various warfare commanders responsible for BLUE force defense. These problems were viewed within the perspective of the current BLUE strategy concerning force passive defense. Again, attachment of the problem which would be developed into an action (sinking) against the intelligence ship proved to be correct.

5. <u>Choice #5</u>

A RED force submarine is suspected to be hiding beneath an unidentified merchant vessel. This choice situation was defined by the BLUE force Surface Warfare Commander and confirmed through the lack of firm intelligence concerning the problem of the position of the unknown RED force submarine. If the submarine is beneath the merchant, the merchant may be providing targeting data to the submarine. This choice situation was considered the lowest priority of those within the wargame model. Here a "what if" scenario was developed within various subordinate staffs of the Blue force commander. As during any conflict at sea, any unidentified craft must be considered hostile until intelligence dictates otherwise. This, coupled with the fact that Blue intelligence was unable to note the position of a red missile firing submarine, provided the "backdrop" for a potentially dangerous and costly situation for the Blue Force. Additionally, the utilization of a merchant for disguising the location of a submarine is a ruse used by submarine forces throughout the world. Thus, this scenario provided many staff members with the opportunity to devise a "textbook solution" to counter the threat.

Problems 18-20 attached to choice #5:

18. There is ambiguous RED submarine intelligence.

19. An unidentified merchant ship may be providing cover for a RED force submarine.

20. A RED Force submarine's location is unaccounted for.

These problems developed through the lack of BLUE intelligence reports in the message traffic concerning submarine locations and the feeling of insecurity felt by the BLUE force commanders when the merchant was sighted by BLUE aircraft. Additionally, BLUE intelligence was unable to account for the merchant steaming so close to the BLUE main body of ships. The various actions against this supposed threat were discussed in the message traffic as well as in the Commanders' intentions meetings. It was decided that the best course of action was to sink the merchant as a safeguard measure. Unfortunately, the merchant turned out to be a BLUE force hospital ship.

6. Choice #6

The deception group's mission effectiveness is suspect in view of recent BLUE intelligence reports. Choice #6 was decidedly the second most important choice situation which occurred during the wargame. The deception mission charged to these units, if effective, is extremely important from the standpoint of deceiving the enemy as to the location of the Blue force. This deception admittedly places the deception group in danger, but the strategic importance of the intelligence gathered by the force as well as the tactical advantage which can be gained by diverting a

strike away from the main body of the Blue forces justified the risk. Conversely, as mentioned above, if the deception group were discovered as to its mission and unit strength by the Red reconnaissance overflight, valuable air, subsurface and surface assets would be lost to the Blue force. Ambiguous Red intelligence reports which were intercepted by Blue intelligence did not indicate if the deception group was discovered or not. Instead,their ambiguous wording created turmoil within the Blue force as to whether the intercepted messages were intentionally provided to the Blue intelligence sources.

Problems 5-8 are attached to choice #6:

5. There is a possible compromise of the BLUE deception group by a RED Reconnaissance flight. (Blue Deception Force-Message)

6. Intelligence is unclear as to the deception groups mission success. (Blue Intelligence)

7. A RED Force intelligence message is intercepted by BLUE intelligence. (Blue Intelligence)

8. Internal pressure is exerted with the BLUE Force Staff and subordinate commanders to cancel deception operations. (Subordinate Staffs - Voice Transmission)

The problems that are attached to this choice situation are important for several different but related reasons. A decision as to employment of the deception group is extremely important as to their effectiveness as a deception tool and their force utilization as an active BLUE force asset within the force screen. The overflight by RED aircraft is confirmed by the deception group but neither the

deception group nor BLUE intelligence can confirm an actual sighting. The receipt of a RED message by all BLUE units stating that the BLUE force location was unknown could be a ruse. The overall ambiguous information concerning the deception group adds to the internal pressures to have the Task Force Commander retrieve the deception group. As it turned out, the "pressure groups" were wrong. The Task Force Commander decided to let the group remain on their deception mission, and , as was later indicated by message traffic, the RED forces were confused by the group's actions.

V. PROGRAM IMPLEMENTATION

Version 5 of the original Fortran model, introduced by Cohen, March and Olsen in 1972, was a non-interactive, batch oriented process which read entry times for choices, solution coefficients, problems, and two control variables from a separate data file. The nature of the problem and the need to provide a highly interactive process led to modification of version 5. Dr. Daniel Guinier of the Naval Postgraduate School finished construction of such a model in January, 1984. It is this model which was used to evaluate the data described in the preceding chapter. The major computational algorithms remain unchanged from the original version. Changes from the original version do however, include an interactive routine to permit user input and desired output to be read from the console. Also new are expanded input matrices which provide space for a maximum of 100 problems, choices, decision makers and entry times. Energy is held constant for each "step" in the summary statistics output to allow comparison of data in a quantifiable manner. Each of the four variables (load, decision structure, access structure and energy distribution), is exercised in three different modes resulting in the 81 "steps". The model handles solutions by

using a "solution coefficient" for each separate entry time which was held constant for the control case under study.

The simulation is exercised by having the aforementioned variables interact in a system run, permitting observations to be made. Utilizing the data obtained from Seacon 84-1, and our own personal experience of actual at-sea battle group involvement, we have been able to produce data which we believe to be of significant value in the evaluation of the Garbage Can concept for possible use as a kernel in the construction of a battle group commander's decision support system.

The theory of the Garbage Can model focuses on two primary attributes, as previously described: decision maker attention, and flows and timing of decisions, problems and solution alternatives within an organization. [Ref: 6] The questions a decision maker faces in deciding which problems to address and the amount of energy to devote to each one are non-trivial, especially under ambiguous conditions. In a traditional sense, problems surface and decision makers address them by seeking appropriate solutions. But in this model, problems, choice opportunities, choices, decision makers, and solutions all circulate independently of one another. A brief set of program features follows:

1. MATRIX SIZE: The situation under study is limited to 100 decision makers, 100 problems, 100 solutions, 100 choices. 100 entry time periods are available for use.

2. LANGUAGE UTILIZED: The re-coding effort was made in FORTRAN-77 with a high degree of machine independence in mind.

3. INPUT FLEXIBILITY: The user of the system is allowed to enter data from the console directly or to have data read from a previously created file. Also, output modifications are prompted at the conclusion of input requirements.

All decision makers remain in the arena for all time periods. Choices enter the system one per time period for the specified number of time periods; problems enter the arena two per time period for the time periods specified. Both become inactive as choices are made. Here, solutions are modeled using a single coefficient from 0.0 to 1.0, rather than as a specific matrix entity and thus, affords a great deal of flexibility in determining the viability of the model for military application. The importance of the coefficient and its impact on this investigative effort is detailed in the last chapter.

The three decision structures (unsegmented, hierarchical, and specialized), were simulated as in the original model by the creation of three computational matrices. Choices and decision makers are ranked from most to least important as the number of each increases from one. The relationship between problems and choices in the access matrices is functionally identical. As previously described, a similar relationship could be constructed for solutions, but we would lose a valuable analysis tool (in

the solution coefficient) and gain little more than a model greatly increased in complexity.

Here, energy is associated with our decision makers and the problems to which they must attend. The relationship reflects the on-going competition for attention between decision makers and problems[Ref 6]. Each decision maker is given 5.5 units of energy per time period, which may be distributed in three different ways; increasing from 0.1 to 1.0, equally distributed at 0.55, and decreasing from 1.0 to 0.1. These are represented in the model as "-", "=", and "+", respectively. These three energy distributions represent the three generalizations of organizational structure [Ref. 1]. If we consider the most general case, where all decision makers bring the same energy to a choice situation, we see that less important decision makers are given an opportunity to significantly contribute energy to the can due to the large amount of time available to them, and that important decision makers, although constrained by time limits placed upon them, contribute shorter intervals of "quality" time. The "quality" here is due to the important decision maker's experience and accumulated intelligence.

Given that a decision maker or problem is permitted to enter a choice situation, as dictated by the appropriate matrix, attention will be directed toward choices nearest completion or toward choice opportunities with the highest

expected return. A choice is made whenever sufficient energy is present. That sufficiency is determined from the energy distribution at the time and the applied solution coefficient; it must be at least equal to the indicated energy requirement of the total can.

Data are entered in response to user friendly, interactive system prompts. Upon completion of data input, the user is asked for his output desires and is given several options, ranging from an abbreviated summary statistics format to a full-blown, step-by-step data history of the modeling process which provides the user with a graphic representation of the computational matrices for each of the 81 steps.

With data collected and made ready for input to the model, all that remained was to exercise the program and collect the output. The next chapter deals with the output information and offers numerical analysis of the computational results.

VI. SIMULATION RESULTS

Data, as collected and previously described, were entered and run on a DEC Vax 11/780. By far, the most interesting results were obtained from those steps involving the Specialized/Unsegmented access/choice matrix structure. This particular structure affords the highest probability of attaining those characteristics considered most desirable in an operational battle group environment. Similar results were obtained independently by Anderson and Fisher (Carnegie-Mellon University) and echoed in their presentation at the Naval Postgraduate School Joint Workshop on Decision Making in Military Organizations, Monterey, California, January 26-28, 1984 [Ref. 12: p. 10]. In Dr. Anderson's presentation, particular attention was given to the "tree hierarchy". We believe this concept to be closely tied to the CMO "specialized hierarchy", only modified to include specifically defined alternatives. This concept was echoed by Kathleen Carley in her presentation at the same workshop [Ref. 13: p. 7]. Her treatment of the subject was to provide some mechanism for overlap on the part of the separate entities concerned; i.e., access and decision structures. She did this by modifying the specialized hierarchy to include a constant weighting factor and to ultimately produce what she termed a "semi-specialized

hierarchy". We believe both ideas to be of the same general nature; overlap does in fact occur in the decision process. Given the precondition of unclear goals, ambiguous information and fluid participation, the Specialized/ Unsegmented matrix produces the highest level of problem solution by resolution and the lowest occurrences of unsolved problems and wasted energy. Although the mean number of decisions not made in the S/U matrix was somewhat larger than most of the other categories, it is our feeling that the Navy organization benefits more from solving problems than from simply making decisions.

The selection of these three summary statistics from the total output was a non-trivial task. The model provides summary statistics in areas not utilized in this study; the six summary statistics not utilized in our computations are the total number of Active Choice periods (ACp), Changes by decision Makers (CdM), Changes by Problems (C/P), Latent Problem periods (LPp), attached Problem periods (aPp), and periods Decision makers resting (pDr). Active choice periods and latent problem periods are an important microdivision of the available information and are most probably valuable in a study of the particulars of a given matrix manipulation, but provide no additional information toward the evaluation of a specific matrix hierarchy. Changes by decision makers and problems may be interesting should the investigation include a prediction of optimum

solution coefficient values or a study of decision maker movement. The number of attached problem periods might provide an interesting input to a study of solution attractiveness or effectiveness. We find the number of periods when decision makers rested to be of little value. Although these are interesting sources of information, we felt their inclusion to be an unnecessary complication given the scope of this investigation; i.e., "given the results of a quantifiable run, which matrix hierarchy solves the largest number of problems, wasting the least amount of energy?".

Based on numerous flag officer interviews and an exhaustive literature survey, the high overload and low decision maker slack typical of a battle group environment, forces decision makers to make decisions, to solve problems, and do so with a net conservation of energy. Simply stated, we seek the structure we believe to be most beneficial to the Navy organization and most appropriate for utilization as a logical kernel in the construction of a battle group commander's decision support system. A summary of the statistical results obtained from exercising the model with the data previously described follows in the next section.

A. STATISTICAL FINDINGS

The numerical output of the Guinier modified version of the CMO (version five) model was obtained by running the

SEACON 84-1 data previously described. From the Summary Statistics, we are given an excellent picture of what has occurred in the model itself and are able to determine which of the hierarchy structures affords us optimum results in terms we can quantify: decisions made or not made, problems solved or not solved, and wasted energy. A basic assumption on our part is that the Navy organization benefits from decisions made (as opposed to decisions not made), from problems solved (as opposed to those not solved), and from the elimination of wasted energy--energy which could better be used in solving additional problems. We believe, therefore, that the Navy organization will profit by reducing the number of decisions not made, the number of problems not solved, and the amount of energy wasted.

A numerical comparison of the three specific means (x) of the Summary Statistics in Appendix A was made using the following statistical tools:

SDX = s_{n-1} = standard deviation

MX = $\overline{x}$ = average value of x

SX = Sum of x ($\sum x$)

SX2 = Sum of x squared $\sum(x_i^2)$

N = Data n

SEN = s_{n-1}/sqr N

t = abs (x1-x2)/(s*sqr(1/n1 + 1/n2))

F = $s1_{n-1}$**2/$s2_{n-1}$**2

Below is a chart summarizing the findings of the analysis of the three specific summary statistic means over all loads for the 81 steps produced in the model run of all nine hierarchical structures. For reference, the standard deviation (s_{n-1}) follows each statistic in parentheses:

Table I. Summary Statistics for Means Over All Loads

MATRIX STRUCTURE	N	Decisions not Made	Problems not Solved	Wasted Energy
S/U	9	1.22 (1.20)	5.88 (4.80)	6.41 (3.14)
S/H	9	3.00 (1.65)	10.44 (6.61)	3.18 (2.90)
S/S	9	4.33 (1.50)	12.55 (8.69)	0.67 (0.58)
H/U	9	0.66 (0.50)	10.00 (7.54)	41.92 (23.74)
H/H	9	0.66 (0.50)	11.11 (8.37)	37.20 (26.69)
H/S	9	1.11 (0.33)	18.88 (1.45)	9.40 (3.23)
U/U	9	0.66 (0.50)	13.33 (10.00)	71.86 (26.50)
U/H	9	0.88 (0.33)	17.77 (6.66)	54.48 (19.18)
U/S	9	1.00 (0.00)	20.00 (0.00)	16.94 (0.30)

A complete list of program results is listed in Appendix A. In general, our findings are consistent with the CMO model. The original model used artificially created data for the program run. We have used empirical data from a real military exercise to test and evaluate the model.

Our evaluation began with an analysis of the summary statistics previously described and a comparison of the means (x) in each category. The optimum hierarchical combination was not readily apparent. Even in the S/U hierarchy, most problems were not solved, some decisions never were made, and the amount of wasted energy was higher

than that found in other categories. Also, although a large number of decisions were made, often the number of problems not solved remained high. (The reader is directed to an earlier explanation in this work describing the difference between decision making and problem solving.) The two would seem to indicate that the decision process is not always aimed at problem resolution. We believe this to be absolutely true. Some problems, by their nature, have no solutions, but require attached decisions to be made--often important decisions--on a daily basis. The military has many such problems and they confront our flag officers frequently.

Another readily observable result concerns load. As the load in a given hierarchical structure increases, the number of decisions not made (DnM) and problems not solved (PnS) increases. Such is to be expected from a given organization; what was somewhat reassuring in the original analysis was that as load increased, wasted energy in the S/U model in fact, decreased from 8.98 to 2.56. The implication here is that, of the energy available, more was being used in the attempt to make decisions and solve problems. The summary statistics in Appendix A show also that decision maker activity, problem activity, and choice activity all increased as load increased. One researcher has addressed this situation by stating that as the density of choice opportunities increases, decision makers are

presented with a larger number of choice opportunities from which to choose. The result is that each opportunity attracts a smaller number of decision makers. "Because resolving a choice opportunity requires the agreement of all those who participate, the fewer the number who attend, the more likely they will agree on a set of solutions" [Ref. 12: p. 14].

A number of researchers have begun investigating the Garbage Can process as a viable model for automating the decision process. The techniques, modifications and results have been carefully cataloged and reported, and the consensus is that, while there are differences between different models, their cumulative results reflect the central properties one could reasonably expect from the original model.

Given the statistical results of the 81 steps, the last task in identifying the optimum hierarchy matrix was to perform a routine statistical hypothesis-testing operation for numerical validity, addressing the system conditions of independent sampling and normally distributed components. To accomplish this task, we chose first, to determine the standard error of the mean (SEN), then to test that number against its "closest competitor" for significance (given n-1 degrees of freedom) in a standard "Student-t test", and then to determine the validity of that test, using a standard "F"

test [Ref. 14: p. 103, Ref. 15: p. 116]. The results of those tests are summarized in the chart on the next page.

The question under study is a determination of whether the lower incidence of Problems not Solved, Decisions not Made, and the smaller amount of Wasted Energy actually occurs consistently as indicated in our results, or whether we are looking at an isolated, rare instance. The hypothesis we propose is that the S/U hierarchy provides the lowest number of Problems not Solved and Decision not Made, and results in the smallest amount of Wasted Energy.

Our results show that there is less than a 5% chance of a Type I statistical error in assuming that hypothesis to be correct for all categories of comparison, excepting that of Decisions not Made. Here, the results would indicate that the Unsegmented and Hierarchical structures perform at least as well, and often do better than the structure under study. Note, however, that the total difference in the Decisions not Made (DnM) does not exceed one decision.

Rather than attempt an analysis of all results for all steps in the computational process, we have included the statistical computations previously referenced as Appendix B.

Table II. Statistical Hypothesis - Test Results

Decisions not Made

STRUCTURE	DoF	SEN	t-test	F-test
S/U only	8	0.400	N/A	N/A
S/U to S/H	16	0.550	6.86	0.529
S/U to H/U	16	0.166	7.05	5.760
S/U to U/U	16	0.166	7.04	5.760

Problems not Solved

STRUCTURE	DoF	SEN	t-test	F-test
S/U only	8	1.6	N/A	N/A
S/U to S/H	16	2.203	4.39	0.527
S/U to H/U	16	2.513	3.47	0.405
S/U to U/U	16	3.333	4.47	0.230

Wasted Energy

STRUCTURE	DoF	SEN	t-test	F-test
S/U only	8	1.040	N/A	N/A
S/U to S/H	16	1.046	6.55	1.17
S/U to H/U	16	7.913	9.52	0.02
S/U to U/U	16	8.333	16.66	0.014

APPENDIX A

MX = Average ($\bar{x}$)

SDXN = Standard deviation (s_n)

SDX = Standard deviation (s_{n-1})

SX = Sum of x ($\sum x$)

SX2 = Sum of x squares ($\sum x^2$)

N = Data n

Total ALL Steps, ALL loads

	DnM	PnS	WE
MX	1.5061	13.7901	26.9004
SDXN	1.4834	7.3463	28.4884
SDX	1.4926	7.3920	28.6659
SX	122	1117	2178.94
SX2	362	19775	124353.
N	81	81	81

Total ALL except S/U

MX	1.5416	14.7777	29.4611
SDNX	1.5178	7.0261	29.2049
SDX	1.5284	7.0754	29.4099
SX	111	1064	2121.2
SX2	337	19278	123903.
N	72	72	72

Total S/U, ALL loads

	DnM	PnS	WE
MX	1.2222	5.8888	6.4155
SDNX	1.1331	4.5324	2.9627
SDX	1.2018	4.0874	3.1424
SX	11	53	57.74
SX2	25	497	449.43
N	9	9	9

TOTAL S/H, ALL loads

MX	3	10.4444	3.1877
SDNX	1.5634	6.2380	2.7350
SDX	1.6583	6.6164	2.9009
SX	27	94	28.690
SX2	103	1332	158.78
N	9	9	9

TOTAL S/S, ALL loads

MX	4.333	12.555	0.6722
SDNX	1.414	8.1936	0.5540
SDX	1.5	8.6906	0.5876
SX	39	113	6.05
SX2	187	2023	6.8295
N	9	9	9

TOTAL U/U, ALL loads

MX	0.6666	13.333	71.867
SDNX	0.4714	9.4280	25.037
SDX	0.5	10	26.555
SX	6	120	646.81
SX2	6	2400	52126.
N	9	9	9

TOTAL U/H, ALL loads

	DnM	PnS	WE
MX	0.8888	17.777	54.484
SDNX	0.3142	6.285	18.088
SDX	0.3333	6.666	19.185
SX	8	160	490.36
SX2	8	3200	29661.
N	9	9	9

TOTAL U/S, ALL loads

MX	1	20	16.94
SDNX	0	0	0.2857
SDX	0	0	0.3031
SX	9	180	152.46
SX2	9	3600	2583.4
N	9	9	9

TOTAL H/U, ALL loads

MX	0.6666	10	41.923
SDNX	0.4714	7.1180	22.382
SDX	0.5	7.5498	23.741
SX	6	90	377.31
SX2	6	1356	20326.
N	9	9	9

TOTAL H/H, ALL loads

MX	0.6666	11.111	37.208
SDNX	0.4714	7.8943	25.165
SDX	0.5	8.3732	26.692
SX	6	100	334.88
SX2	6	1672	18160.
N	9	9	9

TOTAL H/S, ALL loads

MX	1.1111	18.888	9.4044
SDNX	0.3142	1.3698	3.0481
SDX	0.3333	1.4529	3.2330
SX	10	170	84.640
SX2	12	3228	879.61
N	9	9	9

APPENDIX B

```
*******************************************************************************

Nb.of Decision Makers:  10
Number of Problems   :  20
Number of Choices    :   6
Number of Entry Time :  28

*******************************************************************************

Problem entry time    :

  2   2   2   2   8   8   9  14  14  14   2   2   2  25  25  25   3   3   4   4

**1***2***3***4***5***6***7***8***9**10**11**12**13**14**15**16**17**18**19**20

Choice entry time     :

  2  12  14  13  25   4
**1***2***3***4***5***6***7***8***9**10**11**12**13**14**15**16**17**18**19**20

Solution coefficient :

0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7
0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7
**1***2***3***4***5***6***7***8***9**10**11**12**13**14**15**16**17**18**19**20

NA=   1    IO=   1    ISTEP=    3    from :    1 to    1


*******************************************************************************

NA=1 : Problems and Decision Makers both move
NA=2 : Decision Makers only move
NA=3 : Problems only move
NA=4 : Neither Problems nor Decision Makers move

*******************************************************************************

IO=1 : Summary Statistics only
IO=2 : Summary Statistics and Histories are printed

*******************************************************************************

ISTEP=1 : Step by Step Operations
ISTEP=2 : STEP1 to STEP2 Operations
ISTEP=3 : All Operations

*******************************************************************************
```

```
**************************************************
* GARCON : Garbage Can Model of Decision Making *
**************************************************
```

No :No.of step
Load :Load factor of Energy request
Acce :Access Structure
Deci :Decision Structure
Ener :Energy Distribution
DnM :Total Decisions not Made
ACp :Total number of Active choice Periods
CdM :Total number of Changes by decision Makers
PnS :Total number of Problems not Solved
C/P :Total number of Changes by Problems
LPp :Total number of Latent Problem periods
aPp :Total number of attached Problem periods
pDr :Total number of periods of Decision makers resting
UEner:Unused Energy
WEner:Wested Energy

* No	Load	Acce	Deci	Ener	DnM	ACp	CdM	PnS	C/P	LPp	aPp	pDr	UEner	WEner*
* 1	0	U	U	-	0	25	60	0	91	0	370	20	7.70	48.77*
* 2	0	U	U	=	0	17	90	0	49	0	191	100	38.50	17.97*
* 3	0	U	U	+	0	25	60	0	91	0	370	20	7.70	48.77*
* 4	0	U	H	-	1	27	40	20	88	0	410	88	45.99	49.21*
* 5	0	U	H	=	0	16	53	0	49	0	183	121	46.58	9.88*
* 6	0	U	H	+	1	27	40	20	88	0	410	88	21.77	70.91*
* 7	0	U	S	-	1	27	18	20	88	0	410	228	86.45	16.59*
* 8	0	U	S	=	1	27	18	20	88	0	410	228	87.78	16.94*
* 9	0	U	S	+	1	27	18	20	88	0	410	228	89.11	17.29*
* 10	0	H	U	-	0	11	70	0	47	12	91	120	46.20	10.27*
* 11	0	H	U	=	0	10	80	0	47	12	79	120	46.20	10.27*
* 12	0	H	U	+	0	11	70	0	47	12	91	120	46.20	10.27*
* 13	0	H	H	-	0	28	46	0	49	12	144	111	51.31	5.16*
* 14	0	H	H	=	0	28	53	0	47	12	129	129	49.66	6.80*
* 15	0	H	H	+	0	21	55	0	47	12	123	136	48.16	8.31*
* 16	0	H	S	-	2	55	17	18	70	12	390	211	81.97	14.05*
* 17	0	H	S	=	1	41	18	16	72	12	362	224	86.24	8.21*

*	18	0	H	S	+	1	46	19	18	78	12	358	211	85.19	15.73*
*	19	0	S	U	-	0	16	120	1	49	114	58	130	50.05	8.98*
*	20	0	S	U	=	0	16	120	1	49	114	58	130	50.05	8.98*
*	21	0	S	U	+	0	16	120	1	49	114	58	130	50.05	8.98*
*	22	0	S	H	-	3	66	61	11	39	114	204	143	69.37	4.06*
*	23	0	S	H	=	1	46	64	5	45	114	149	151	58.13	5.78*
*	24	0	S	H	+	0	32	71	1	49	114	105	164	49.70	9.33*
*	25	0	S	S	-	4	78	13	15	35	114	236	155	71.96	0.96*
*	26	0	S	S	=	1	65	18	5	45	114	199	168	64.68	1.54*
*	27	0	S	S	+	3	71	15	10	40	110	208	165	67.34	1.56*
*	28	1	U	U	-	1	27	60	20	88	0	410	10	3.85	88.55*
*	29	1	U	U	=	1	27	60	20	88	0	410	10	3.85	88.55*
*	30	1	U	U	+	1	27	60	20	88	0	410	10	3.85	88.55*
*	31	1	U	H	-	1	27	40	20	88	0	410	88	45.99	49.21*
*	32	1	U	H	=	1	27	40	20	88	0	410	88	33.88	60.06*
*	33	1	U	H	+	1	27	40	20	88	0	410	88	21.77	70.91*
*	34	1	U	S	-	1	27	18	20	88	0	410	228	86.45	16.59*
*	35	1	U	S	=	1	27	18	20	88	0	410	228	87.78	16.94*
*	36	1	U	S	+	1	27	18	20	88	0	410	228	89.11	17.29*
*	37	1	H	U	-	1	30	90	14	69	12	286	10	3.85	57.75*
*	38	1	H	U	=	1	30	90	14	69	12	286	10	3.85	57.75*
*	39	1	H	U	+	1	30	90	14	69	12	286	10	3.85	57.75*
*	40	1	H	H	-	1	30	43	18	73	12	390	31	13.51	71.42*
*	41	1	H	H	=	1	30	43	18	73	12	390	31	11.94	71.74*
*	42	1	H	H	+	1	29	43	16	79	12	334	65	15.05	57.10*
*	43	1	H	S	-	1	30	18	18	82	12	390	235	83.65	9.12*
*	44	1	H	S	=	1	31	19	20	98	12	398	236	90.86	7.32*
*	45	1	H	S	+	1	31	19	20	98	12	398	236	97.79	8.26*
*	46	1	S	U	-	1	38	130	5	45	114	136	50	19.25	7.70*
*	47	1	S	U	=	1	38	130	5	45	114	136	50	19.25	7.70*

*	48	1	S	U	+	1	38	130	5	45	114	136	50	19.25	7.70*
*	49	1	S	H	-	4	73	67	15	35	114	226	126	61.95	2.33*
*	50	1	S	H	=	4	71	63	15	35	114	220	130	50.05	1.67*
*	51	1	S	H	+	2	62	69	9	41	114	197	132	36.96	2.96*
*	52	1	S	S	-	5	93	11	18	32	110	278	134	60.69	0.23*
*	53	1	S	S	=	5	103	10	18	32	110	298	124	47.74	0.13*
*	54	1	S	S	+	5	91	11	18	32	110	274	136	50.19	0.23*
*	55	2	U	U	-	1	27	60	20	88	0	410	10	3.85	88.55*
*	56	2	U	U	=	1	27	60	20	88	0	410	10	3.85	88.55*
*	57	2	U	U	+	1	27	60	20	88	0	410	10	3.85	88.55*
*	58	2	U	H	-	1	27	40	20	88	0	410	88	45.99	49.21*
*	59	2	U	H	=	1	27	40	20	88	0	410	88	33.88	60.06*
*	60	2	U	H	+	1	27	40	20	88	0	410	88	21.77	70.91*
*	61	2	U	S	-	1	27	18	20	88	0	410	228	86.45	16.59*
*	62	2	U	S	=	1	27	18	20	88	0	410	228	87.78	16.94*
*	63	2	U	S	+	1	27	18	20	88	0	410	228	89.11	17.29*
*	64	2	H	U	-	1	32	90	16	72	12	344	10	3.85	57.75*
*	65	2	H	U	=	1	32	90	16	72	12	344	10	3.85	57.75*
*	66	2	H	U	+	1	32	90	16	72	12	344	10	3.85	57.75*
*	67	2	H	H	-	1	29	43	16	79	12	334	65	35.00	29.40*
*	68	2	H	H	=	1	29	43	16	79	12	334	65	25.03	38.12*
*	69	2	H	H	+	1	29	43	16	79	12	334	65	15.05	46.83*
*	70	2	H	S	-	1	31	19	20	98	12	398	236	83.93	6.37*
*	71	2	H	S	=	1	31	19	20	98	12	398	236	90.86	7.32*
*	72	2	H	S	+	1	31	19	20	98	12	398	236	97.79	8.26*
*	73	2	S	U	-	3	52	120	13	37	114	183	30	11.55	3.85*
*	74	2	S	U	=	2	49	130	9	41	114	172	30	11.55	0.00*
*	75	2	S	U	+	3	52	120	13	37	114	183	30	11.55	3.85*
*	76	2	S	H	-	5	82	44	18	32	110	256	111	55.44	0.00*
*	77	2	S	H	=	4	75	63	15	35	114	231	115	44.27	0.39*

*	78	2	S	H	+	4	74	63	15	35	114	228	117	31.92	2.17*
*	79	2	S	S	-	5	101	11	18	32	110	294	126	55.09	0.70*
*	80	2	S	S	=	6	104	10	20	30	110	300	124	47.74	0.00*
*	81	2	S	S	+	5	99	11	18	32	110	290	128	44.59	0.70*

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Thesis
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Application of the Cohen, March and Olsen ''Garbage Can'' process theory to the operational Battle Group Commander.